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Ocellularia lumbschii and *O. saxicola* spp. nov. from Vietnam

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Abstract — Two new species of thelotremoid *Graphidaceae*, *Ocellularia lumbschii* and *O. saxicola*, are described from the Central Highlands of Vietnam. *Ocellularia lumbschii* has an off-white to creamish shiny smooth thallus, apically carbonized excipulum and columella, transversely septate ascospores (20–27 × 7–8 µm), and isonotatic and norisonotatic acid. *Ocellularia saxicola* is characterized by a grey-white to silver-white thallus, hyaline to pale brown proper exciple, slightly carbonized columella developing in mature ascomata, submuriform ascospores (22–27 × 7–9 µm), and psoromic acid. Two other species, *O. fumosa* and *O. minutula*, represent new records for Vietnam. A working key to the *Ocellularia* from Vietnam is presented.

Key words — Chu Yang Sin National Park, lichens, taxonomy, *Thelotremataceae*, tropics

Introduction

During the recent investigations on the lichen biota of Vietnam, several rich elements of tropical lichenized ascomycetes have been found (Joshi et al. 2013a, b). The most diverse group of crustose lichens in Vietnam is the order *Ostropales*, in which the *Graphidaceae* form the largest component of tropical species and comprise more than 2500 species worldwide (Lücking et al. 2009; Rivas Plata et al. 2012a; Kraichak et al. 2014). In Vietnam, approximately 50 species of *Graphidaceae* have so far been recorded (Aptroot & Sparrius 2006; Joshi et al. 2013a, b), including those previously placed separately in the *Thelotremataceae*. Aptroot & Sparrius (2006) reported ten species of thelotremoid lichens from Vietnam in the genera *Chroodiscus*, *Myriotrema*, *Thelotrema*, and *Ocellularia*. However, following the recent modification of taxonomic and systemic concepts in this group, some of these species are now accommodated in *Chapsa*, *Leucodecton*, and *Rhabdodiscus*.

Ocellularia G. Mey. comprises more than 300 species world-wide (Frisch et. al. 2006; Mangold et al. 2009; Rivas Plata et al. 2012b Kraichak et al. 2014; Pelaez et al. 2014) and accommodates species with usually round and porinoid apothecia, a ± carbonized proper exciple lacking lateral paraphyses, and columellate structures. The genus has not been thoroughly investigated in Vietnam where only seven species have been reported (Aptroot & Sparrius 2006; Joshi et al. 2013a): *Ocellularia allosporoides* (Nyl.) Patw. & C.R. Kulk., *O. asiatica* (Vain.) Hale [≡ *Rhabdodiscus asiaticus* (Vain.) Rivas Plata et al.], *O. dolichotata* (Nyl.) Zahlbr., *O. papillata* (Leight.) Zahlbr., *O. perforata* (Leight.) Müll. Arg., *O. tenuis* (Hale) Hale, and *O. thelotremoides* (Leight.) Zahlbr. Here we describe two new *Ocellularia* species, *O. lumbschii* and *O. saxicola*, recently collected from the Central Highlands of Vietnam. We also report two new Vietnamese records (*O. fumosa, O. minutula*) and provide an artificial key to the *Ocellularia* species recorded from Vietnam.

Materials & methods

A lichenological expedition at Chu Yang Sin National Park in the Central Highland area in Vietnam was organized in 2013 by Prof. A.D. Ngyuen, Tay Nguyen University, Vietnam. The specimens were deposited in the lichen herbarium of the Korean Lichen Research Institute, Suncheon, Korea (KoLRI), and were studied to identify the thelotremoid species; duplicate specimens were preserved in the Biotechnology Center of Tay Nguyen University, Buon Ma Thuot City, Vietnam (BCTNU). The morphology was examined under a dissecting microscope (SMZ 168), while anatomical observations of thin hand-cut sections of thallus and ascomata were observed in tap water and measured using a compound microscope (Olympus BX50). Colour spot reaction tests and thin-layer chromatography (TLC) were adapted from Orange et al. (2001). Thin-layer chromatography was performed in solvent systems A [toluene (180): 1, 4-dioxane (45): acetic acid (5)] and C [toluene (170): acetic acid (30)]. Lugol's solution (I) was used to check the amyloidity of the asci, interascal filaments, and ascospores. The measurements were based on 20–25 sections of the thallus and ascomata. Relevant literature on thelotremoid lichens (Hale 1981; Nagarkar & Hale 1989; Awasthi 1991; Nagarkar et al. 1988; Homchantara & Coppins 2002; Frisch et al. 2006; Mangold et al. 2009; Rivas Plata et al. 2010) was consulted for species identifications. Images were taken using Zeiss Scope A1 (AX10) and Axio cam ERc 5s, and illustrations were prepared using Coral Draw (version 12).

Taxonomy

Ocellularia lumbschii S. Joshi & Hur, **sp. nov.** Pl. 1

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Differs from *Ocellularia chonestoma* by its off-white thallus and its apically carbonized excipulum and columella

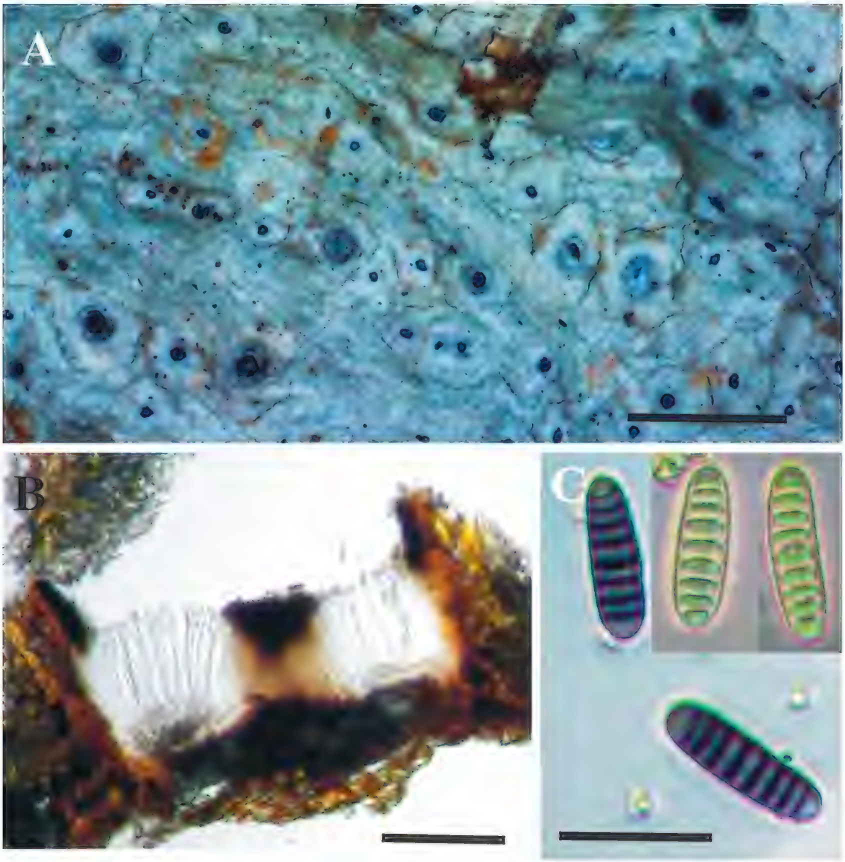

Plate 1. *Ocellularia lumbschii* (holotype, KoLRI). A. habit; B. cross section of ascoma; C. transversely septate ascospores (note I+ blue reaction). Scale bars: A = 1 mm; B = 150 µm; C = 25 µm.

Type: Vietnam, Dak Lak province, Chu Yang Sin National Park, 12°27′57″N 108°20′34.9″E, alt. 780 m, on bark, 21 April 2012, Hur & Oh VN120024 (**Holotype**, KoLRI; **isotype**, BCTNU).

Etymology: The new species is named in honour of the prominent lichenologist, Dr. H.T. Lumbsch.

Thallus corticolous, epiperidermal, off-white to creamish, ± shiny, smooth, uneven due to the substrate, 200–250 µm thick; cortex continuous, made up of periclinal hyphae, 20–25 µm thick; algal layer continuous, inspersed with crystals, 100–130 µm thick; medulla white, crystalline, indistinct, mostly endoperidermal; prothallus whitish.

Ascomata apothecioid, porinoid with round margins, immersed to slightly emergent, solitary, dispersed, 0.4–0.6 mm in diam.; pore rounded, lined by whitish thalline rim, filled by the tip of columella, 0.15–0.17 mm in diam.; disc not seen from above, flesh coloured; thalline margin slightly raised, 100–200 µm thick; proper exciple apically carbonized, fused, surrounded by periderm layer 40–70 µm thick; epihymenium greyish, crystalline, ≤15 µm high; hymenium hyaline, clear, 80–130 µm high; paraphyses lax, simple, unbranched, 1–2 µm thick; subhymenium hyaline, 20–30 µm high; columella simple, cylindrical, apically carbonized, 200–250 µm in width; asci narrowly clavate, uni- to biseriate, 8-spored, 80–100 × 15–17 µm, I–; ascospores hyaline, transversely septate, 7–9-loculate, oblong to ellipsoidal, with rounded ends, 20–27 × 7–8 µm, I+ blue, halo not seen.

Chemistry: K+ yellow, PD–, C–, KC–; isonotatic and norisonotatic acids detected in TLC.

Distribution & ecology: The new taxon is known only from its type locality in Vietnam, where it was growing on thin bark of trees in evergreen forests, at an altitude between 600–700 m. The associated species growing in the same forest climate were *Rhabdodiscus asiaticus*, *Ocellularia allosporoides*, *O. papillata*, *O. thelotremoides*, and members of lirellate graphioid taxa.

Additional specimen examined: VIETNAM. Dak Lak province: Chu Yang Sin National Park, 12°28′04.4″N 108°20′39″E, alt. 622 m, on tree, 20 April 2012, Hur & Oh VN120060 (KoLRI, BCTNU).

Remarks: *Ocellularia lumbschii* is well characterized by its off-white epiperidermal thallus, immersed to slightly emergent ascomata, apically carbonized proper exciple and columella, transversely 6–8-septate ascospores, and the presence of unknown compounds. *Ocellularia chonestoma* (Leight.) Zahlbr., which also produces transversely septate ascospores of 18–30 × 5–6 µm and isonotatic and norisonotatic acids, differs from *O. lumbschii* chiefly by its olivaceous thallus and fully carbonized excipulum and columella. *Ocellularia roseotecta* Homchant. & Coppins is similar to the new taxon in having immersed to ± emergent ascomata, an apically carbonized excipulum and columella, and transversely septate ascospores, but its pigmented medulla, slightly smaller (15–25 × 6–8 µm) ascospores, and unidentified compound (reacting PD+ orange) separate *O. roseotecta* from *O. lumbschii*. *Ocellularia pyrenuloides* Zahlbr., which shares transversely septate ascospores (≤30 × 5–8 µm), an apically carbonized excipulum, and a simple, carbonized columella with the new species, differs in producing the stictic acid chemosyndrome. Other similar species with transversely septate ascospores and the same chemistry as *O. lumbschii* are *O. allosporoides*, which has fully carbonized excipula and columellae, and larger ascospores, 50–120(–130) × 10–18 µm (Mangold et al. 2009), and *O. baileyi* Müll. Arg., which has fully carbonized excipula and columellae and a pink medulla (Mangold et al. 2009).

Ocellularia saxicola S. Joshi & Hur, **sp. nov.** Pl. 2

MycoBank MB812263

Differs from *Ocellularia planaria* by its small ascomata, distinctly submuriform and rather large ascospores, and saxicolous habitat.

Type: Vietnam, Dak Lak province, Chu Yang Sin National Park, 12°27′57″N 108°20′34.9″E, alt. 780 m, on rock, 21 April 2012, Hur & Oh VN120129 (**Holotype**, KoLRI; **isotype**, BCTNU).

Etymology: The specific epithet refers to the rock habitat of the new species.

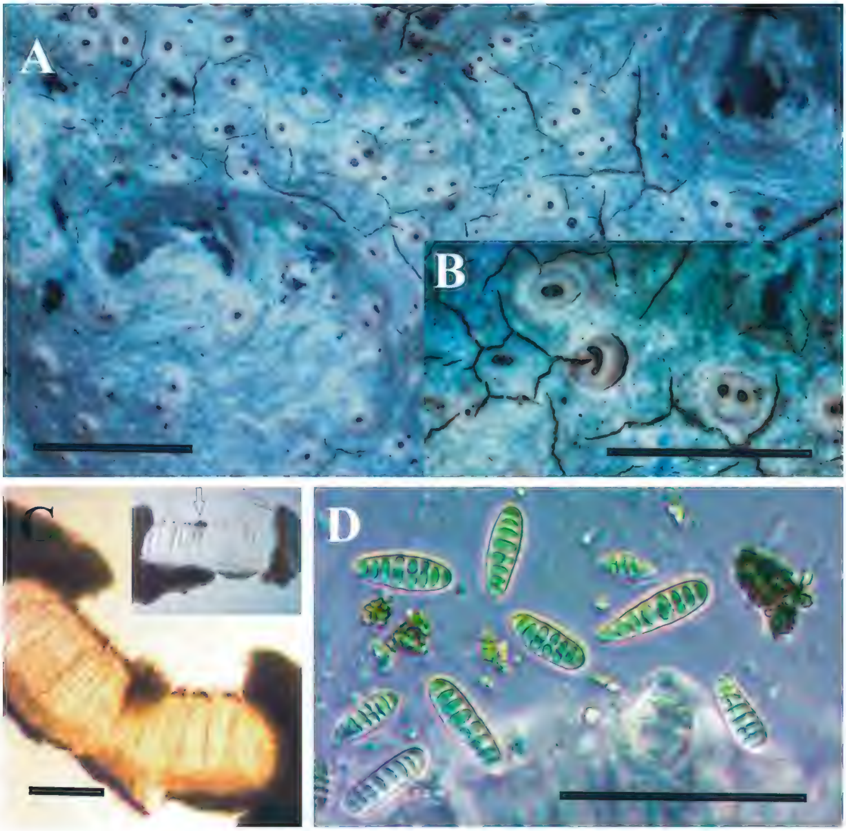

Plate 2. *Ocellularia saxicola* (holotype, KoLRI). A. habit; B. ascomata; C. cross section of ascoma (note the developing columella and brown excipulum); D. ascospores. Scales: A = 1 mm; B = 0.5 mm; C = 100 μm; D = 50 μm.

Thallus saxicolous, epilithic, off-white, grey-white to silver-white, corticate, shiny, smooth, coarsely cracked due to the substratum, 150–200 µm thick; cortex continuous, made up of periclinal hyphae, thin, 15–20 µm; algal layer continuous, inspersed with crystals, 90–100 µm; medulla white, crystalline, epi- to endolithic, 70–90 µm; prothallus not seen.

Ascomata apothecioid, porinoid with round margins, immersed, solitary to rarely fused in aggregates of 2 or 3, 0.1–0.25 mm in diam.; pore 0.05–0.1 mm in diam., lined by entire, pale brown to creamish thalline margin; disc mostly visible, flesh coloured, thinly covered by white pruina; thalline margin inconspicuous, whitish than the thallus, rarely erumpent, up to 80 µm thick; proper exciple fused, brownish to ± hyaline, becoming carbonized apically in mature ascomata, 20–30 µm thick; epihymenium greyish, granular, crystalline, indistinct to 15 µm high; hymenium hyaline, clear, 120–150 µm high; paraphyses rather lax, simple, unbranched, 1–2 µm thick; subhymenium hyaline, 30–40 µm high; columella seen only in mature and fused ascomata, apically well developed, brown to slightly carbonized in late maturity 80–100(–120) µm in width; asci narrowly clavate, uni- to biseriate, 8-spored, 100–135 × 10–18 µm, I–; ascospores hyaline, submuriform, 8 × 1–2- loculate, subglobular to oblong, 20–27 × 7–9 µm, I+ violet-blue, halonate, halo up to 5 µm thick.

Chemistry: K–, PD+ golden yellow, C–, KC–; psoromic acid detected in TLC.

Distribution & ecology: The new species is known only from its type locality in Vietnam, where it was spreading on uneven rock surfaces along with other porinoid members of the thelotremoid group at an altitude between 700–800 m.

Additional specimens examined: VIETNAM. Dak Lak province: Chu Yang Sin National Park, 12°28′04.4″N 108°20′39″E, alt. 622 m, on rock, 20 April 2012, Hur & Oh VN120036 (KoLRI, BCTNU); 12°28′12.3″N 108°20′59.9″E, alt. 763 m, on rock, 20 April 2012, Hur & Oh VN120082 (KoLRI, BCTNU).

Remarks: *Ocellularia saxicola* is characterized by its grey- to silver-white, shiny, and continuous to ± cracked thallus, a pale brown to apically carbonized excipulum, a poorly developed, brownish to carbonized, thin columella usually seen in mature or fused ascomata, submuriform ascospores, and its psoromic acid chemistry. The new species closely resembles *O. planaria* (Hale) Hale in having a grey-white thallus producing psoromic acid and ecolumellate to columellate flush ascomata. However, *O. planaria* differs in its somewhat larger (0.4–0.8 mm) ascomata, transversely septate ascospores of 15–20 × 9–10 µm, and corticolous habit. *Rhabdodiscus asiaticus* is close to *O. saxicola* in having ascospores ≤30 × 7–10 µm and a thallus producing psoromic acid, but differs in its greyish to pale greenish or olive verrucose thallus, emergent and larger

(≤1.4 mm wide) hemispherical to urceolate ascomata, a carbonized excipulum, a well developed columella up to 800 µm thick with distinct carbonization, and corticolous habit. Two other psoromic acid containing species, *O. minutula* and *O. terebrata,* also have similar ascospore dimensions (*O. minutula*, 20–30 × 6–8 µm; *O. terebrata*, 17–32 × 7–10 µm) and a weakly developed columella similar to the new species, but their ± warty thallus, transversely septate and non-halonate ascospores, and corticolous habit clearly distinguish them from *O. saxicola*.

Ocellularia minutula Hale, Smithsonian Contr. Bot. 38: 24, 1978.

This corticolous species is characterized by a green to olive-green, smooth, dull to ± glossy, continuous thallus; inconspicuous, immersed, solitary to fused, round, porinoid apothecia, 0.1–0.2 mm wide; the pore filled by columella at maturity; a disc not visible from above; a brown to slightly carbonized proper exciple; a thick, brownish to slightly carbonized, weakly developed entire columella, 100-120 µm thick; a hyaline, indistinct epihymenium; hyaline, clear hymenium, 140–150 µm; 8-spored asci; hyaline, transversely septate, oblong to ellipsoidal, distinctly amyloid ascospores, 18–22 × 6–8 µm, and the presence of psoromic acid in the thallus. The material examined closely resembles *O. terebrata* in apothecial anatomy and chemistry but differs in having a thinner thallus and mostly immersed apothecia with small pores. The species has a pantropical and southern temperate distribution (Mangold et. al. 2009).

Specimen examined: VIETNAM. Dak Lak province: Chu Yang Sin National Park, 12°27′57″N 108°20′34.9″E, alt. 936 m, on tree, 21 April 2012, Hur & Oh VN120269 (KoLRI, BCTNU).

Ocellularia fumosa (Ach.) Müll. Arg., Mém. Soc. Phys. Genève 29(8): 7, 1887.

This corticolous species is characterized by a pale-green to olive-green, ± verrucose, dull to ± glossy, continuous thallus; conspicuous, round, porinoid apothecia, up to 0.8 mm, which are immersed to prominent at maturity, solitary or in aggregates of two or three; a greyish disc; pores filled by columella at maturity; a brown to slightly carbonized proper exciple; brownish to apically carbonized, entire columella distinct in mature apothecia and 100–120 µm thick; a hyaline, indistinct epihymenium; a hyaline, densely inspersed hymenium, 120–150 µm thick; 8-spored asci; hyaline, transversely septate, oblong to ellipsoidal, distinctly amyloid ascospores, 30–45 × 6–9 µm, and a thallus producing hirtifructic and conhirtifructic acids as major compounds, and cinchonarum unknown and other accessory compounds in traces. It differs from *O. amplior* (Nyl.) Redinger, another species with inspersed hymenium, in having a columella and in its chemistry. The species has a pantropical distribution (Mangold et al. 2009).

Specimen examined: VIETNAM. Dak Lak province: Chu Yang Sin National Park, 12°28′04.4″N 108°20′39″E, alt. 622 m, on tree, 20 April 2012, Hur & Oh VN120297 (KoLRI, BCTNU).

Key to *Ocellularia* species recorded from Vietnam

Data for *O. dolichotata* and *O. tenuis* from Awasthi (1991) and Mangold et al. (2009)

1. Asci 2-spored; thallus ashy-white, grainy verruculose; ascomata emergent; columella carbonized; ascospores transversely septate, 120–200 × 15–20 µm; no lichen substances present .... ***O. dolichotata***

1. Asci 8-spored 2

2. Hymenium inspersed; ascospores transversely septate, 30–45 × 6–9 µm; hirtifructic acid present .... ***O. fumosa***

2. Hymenium not inspersed 3

3. Lichen substances present 4

3. Lichen substances absent 9

4. Psoromic acid present 5

4. Psoromic acid absent 6

5. Ascospores submuriform, 20–27 × 7–9 µm, halonate; proper exciple mostly hyaline to pale brown; thallus off white to grey, smooth, saxicolous. .... ***O. saxicola***

5. Ascospores transversely septate, 18–22 × 6–8 µm, non-halonate; proper exciple brown to slightly carbonized; thallus in shades of green, ± warty, corticolous .... ***O. minutula***

6. Isonotatic and norisonotatic acids present 7

6. Protocetraric acid present 8

7. Thallus green to olive-green; ascomata usually emergent; proper exciple and columella mostly fully carbonized; ascospores transversely septate, hyaline, 60–70 × 8–12 µm .... ***O. allosporoides***

7. Thallus off-white; ascomata immersed to slightly emergent; proper exciple and columella apically carbonized; ascospores transversely septate, hyaline, 20–27 × 7–8 µm .... ***O. lumbschii***

8. Ascospores submuriform, 24–26 × 12–13 µm; proper exciple rarely marginally carbonized; columella entire, brownish to carbonized .... ***O. thelotremoides***

8. Ascospores transversely septate, 20–32 × 6–9 µm; proper exciple brown, rarely marginally carbonized; columella entire, brownish to carbonized ... ***O. perforata***

9. Ascospores transversely septate, 19–20 × 6–7 µm; ascomata conspicuous, immersed to moderately emergent; proper exciple apically to marginally carbonized; columella developed at maturity, brown to carbonized. ... ***O. papillata***

9. Ascospores transversely septate to submuriform, 10–20 × 5–8 µm; ascomata inconspicuous, immersed; proper exciple marginally carbonized; columella developed at maturity, carbonized .... ***O. tenuis***

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